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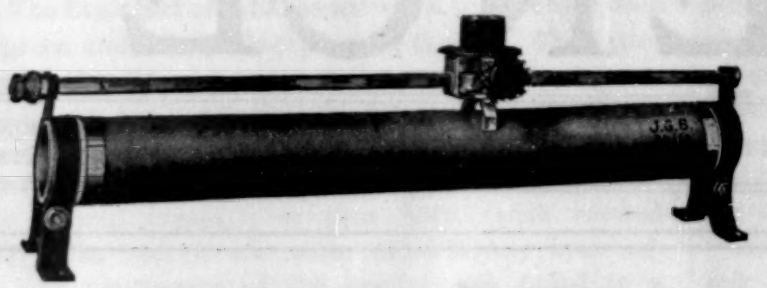

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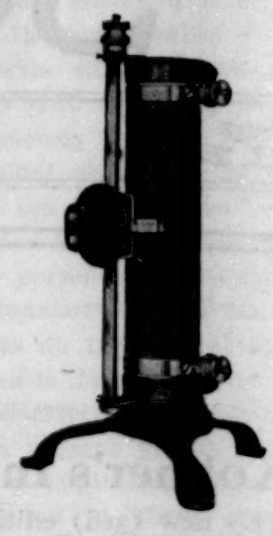

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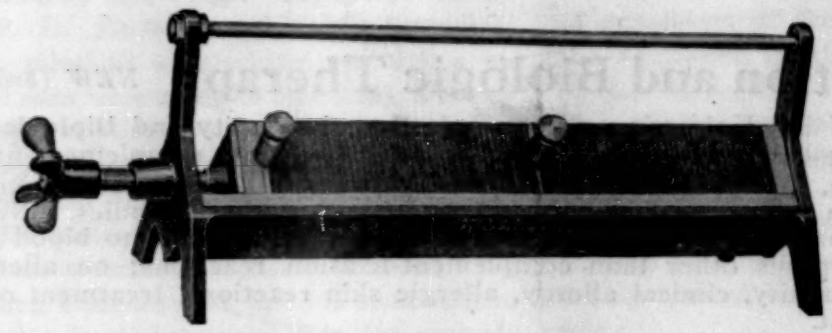

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THE ATOMIC THEORY FROM THE STANDPOINT OF MAGNETISM[1]

WHEN any substance is exposed to the influence of a magnetic field it behaves in various ways, depending upon the physical and chemical properties of the material examined. Oxygen is attracted to the poles of a magnet, while carbon dioxide is repelled. Bismuth shows a marked change in resistance when magnetized and copper only slightly. Varying degrees of hardness in steel are accompanied by corresponding changes in length due to a magnetic field. Each substance discloses its own peculiar temperament in a magnetic field, whether it be a gas, a liquid or a solid.

Magnetic phenomena are classified as effects according to the form of behavior which matter is observed to undergo when magnetized. If a magnetic field changes the optical properties of a substance it is called a magneto-optical effect, which is a very suggestive term. Unfortunately, corresponding terms to designate those effects which are produced when a magnetic field changes the mechanical, acoustical, electrical, magnetical and thermal properties of matter have not been adopted to any great extent, and while it may be unorthodox, nevertheless, such a division gives an excellent bird's-eye view of magnetic phenomena. Introducing these terms which would correspond to the term magneto-optical, the following outline of magnetic phenomena is herewith given.

OUTLINE OF MAGNETIC PHENOMENA

(1) Magneto-Magnetics	The magnetic field, forces in dia, para and ferromagnetism. Magnetic induction, intensity, hysteresis, permeability, susceptibility, coercive force, retentivity, reluctance and leakage.
(2) Magneto-Mechanics	Joule effect—Villari effect—Wiedemann effect—2nd. and 3d. Wiedemann effect—Barrett effect—converse effect—Wertheim effect—Piezo effect. Change in moduli. Volume change on solidification.
(3) Magneto-Acoustics	Production of sound by magnetization "magnetic tick."

[1] Read before the chemistry and physics section of the Mid-year Educational Conference held at the Michigan State Normal College, Ypsilanti, January 18 and 19, 1924.

	Barkhausen effect.
	Influence of magnetism on periodicity.
	Influence of vibrations on magnetism.
(4) Magneto-Electrics	Hall effect.
	Change in resistance.
	I and II v. Ettingshausen and Nernst effects.
	Change in Thermo-Electric properties.
	Induced currents—A. C., electrodeless discharge, etc.
	E. M. F. due to magnetization.
(5) Magneto-Thermics	Leduc effect.
	Change in heat conductivity.
	Pyromagnetism.
	Critical temperatures and effects of heat.
	Energy dissipation in hysteresis.
	Change in boiling point, in specific heats (?).
	Transverse temperature effects accompanying the Hall effect.
	Change in Thermal E. M. F.
(6) Magneto-Optics	Faraday effect.
	Kerr effects.
	Zeemann effect.
	Magnetic double refraction.
	Effect of light on magnetism.
(7) Cosmical Magnetism	

With a meaning analogous to magneto-optics, magneto-mechanics will include those magnetic phenomena in which mechanical effects occur due to a magnetic field. Changes in dimensions produced by a magnetizing force is an illustration of this type of phenomena. So are also those reciprocal effects in which mechanical stresses produce changes in the magnetic properties of the substance examined. The terms serving as captions for the other subdivisions may be defined in a similar fashion, as, for instance, magneto-acoustics include those phenomena in which sound is produced by a magnetic field as well as those changes in magnetic properties due to vibrations of noises, etc.

If all matter could be examined with reference to the effects classified in these six divisions it would not only be a complete magnetic analysis of all the physical properties, but at the same time would involve all the chemical properties as well. In magneto-optics, for example, if the Faraday effect was studied in all substances it would not be complete until the chemical relations were all known also. Even after a complete magnetic survey of matter was made, the study would not be ended, for there are all sorts of correlations to be made between the six groups of magnetic phenomena. As an illustration, in magneto-acoustics it is observed that the period of a tuning fork is varied by being magnetized. In magneto-mechanics there is the well-known effect that magnetism changes both the dimensions of steel and the modulus of elasticity. Here are several phenomena which may be correlated. To the extent that physical phenomena may be coordinated to that degree may a unified whole be obtained. As another example of correlation it seems to have been rather conclusively established in the field of magneto-mechanics[2] that there is one and only one set of mechanical characteristics corresponding to a given set of magnetic characteristics, and, *vice versa*, there is one and only one set of magnetic characteristics corresponding to a given set of mechanical characteristics. Can this principle which is so important in magnetostriction, for example, be applied to the other five fields of magnetic phenomena? If this is possible, then the generalized statement may be made as follows:

FUNDAMENTAL PRINCIPLE

There is one and only one set of physical and chemical properties corresponding to a given set of magnetic characteristics, and conversely, there is one and only one set of magnetic properties corresponding to a given set of physical and chemical characteristics.

Such a principle suggests a vital relation between magnetism and theories of atomic structure. The electron theory of matter, which has been so helpful in picturing the structure of the atom and adding knowledge concerning the physical and chemical properties of matter, will it portray the phenomena of magnetism? Shall we ultimately be able to isolate the elementary magnet as we have the elementary electrical charge? For instance, if a bar magnet is broken in two, the positive and negative poles will not be separated, but two magnets are formed each with their own positive and negative poles. It is conceivable that if the subdivision went far enough a portion would finally be reached whose division would not result in two magnets. What is that ultimate elementary magnet which shows this property? Is it an electron,[3] an atom,[4] a molecule[5] or an aggregation of one or more of these?[6] This is one of the outstanding questions in the field of magnetism with adherents for all the various points of view.

Naturally, in seeking for an answer to such a

[2] Burrows, Scientific Papers, No. 272, Bur. Stands., 1916.

[3] Compton, *Jour. Frank. Inst.*, August, 1921.

[4] Ewing, Proc. Roy. Soc., p. 97, Vol. 42, 1921–22.

[5] Knowlton, Trans. Faraday Soc., p. 204, October, 1912.

[6] Young, *Phil. Mag.*, p. 305, August, 1923.

question, one turns to the recent developments of atomic models to see what they have to offer by way of explanation of magnetic phenomena. The nucleus atom formulated largely by Rutherford[7] in 1911 has been instrumental in producing some very remarkable advances in both physics and chemistry and is now almost universally accepted as correct in its main principles. The nuclear atom is likened to a planetary system and is assumed to consist of a nucleus surrounded by a number of negatively charged particles called electrons, whose distances from one another and from the nucleus are very large compared to the dimensions of the electrons themselves. These electrons, like planets, revolve about the nucleus in circular and elliptical orbits. The central nucleus contains all the positive electricity in the atom and therefore practically all its mass. Not only its mass but also the radioactive properties of an atom are associated with the nucleus; its chemical properties and spectrum, on the other hand, are properties of its planetary electrons.[7] In the hands of Bohr[8] and Sommerfeld[9] and others who have applied the quantum and relativity theories to this type of atomic structure, this model has been particularly powerful in the analysis of spectral phenomena. Such an atomic model has electrons in it; it goes to make up molecules. Where in such a piece of machinery lies that element which is responsible for magnetic phenomena?

In a recent and very suggestive paper Young[10] has studied the crystal structure of the Heusler alloys, which are magnetic alloys formed from non-magnetic elements. He sets out to learn, if possible, the origin of magnetic phenomena. Discussing the various explanations that have been offered in explanation of the magnetic properties of the Heusler alloys, he finally arrives at the conclusion that "the evidence to date points to the probable seat of magnetic phenomena in the behavior and configuration of the outer or valence electrons," and adds, "this, of course, is in agreement with the well-known changes in magnetic properties that take place as the result of chemical action, and those due to temperature variation which might be expected to have a direct influence on the loosely-bound valence electrons."

At best the picture we draw of the elementary magnet is a hazy one. We can speak of it only in glowing generalities. While we do know a little about the magnetic moment of the elementary magnet, yet we do not seem to be able to bound it as we do the elementary electrical charge. One feels, however, that the picture of negative charges revolving swiftly in orbits about the positive nucleus must, in the end, explain magnetic phenomena, but how? It all means to say that there is a very great need for physicists to turn their attention to sustained research in magnetic phenomena. This need will produce investigators, and it is a fairly safe prediction to make that the next decisive advance in the conception of atomic structures will be in the field of magnetic behavior. There are several lines of research in magnetism that should be pushed at once. One is an investigation of the magnetic properties of *atomic* hydrogen. The magneto-optical behavior of the fine-line spectrum, together with the diamagnetic properties of *molecular* hydrogen, indicate that the molecule of hydrogen should possess no magnetic moment, and which is in accord with Bohr's model. On the other hand, since in the atom of hydrogen there is a single electron cruising around the nucleus there should be a magnetic moment and therefore paramagnetic in its behavior. Experimental confirmation of this would be an important contribution.

Thus far the Rutherford-Bohr-Sommerfeld atom has contributed largely to the theory of the origin of spectra. For that reason an extensive study of the Zeemann effect would add to our knowledge of how magnetic phenomena are related to atomic structures.

From a rather extended study of magnetostrictive phenomena one is led to the point of view that if magnetic phenomena are due to the outer or valence electrons, then the spatial distribution of these electronic orbits are exceedingly important. This is supported in particular by the effect of temperature treatment (hardness) as related to the changes in length produced by a magnetic field (Joule effect). Bohr[11] has emphasized this point of spatial distribution of the electronic orbits in the atoms in seeking for "the ultimate cause of the pronounced stability of certain arrangement of electrons." If the spatial distribution of the orbits within the atom is important, no less so is it in the internuclear space. The work of Hull[12] in showing that the property of ferromagnetism does not depend upon the arrangement of atoms so much as upon the distance between them confirms this important point of view. It is supported by the work of Perrier and Onnes[13] in a study of the paramagnetism of liquid oxygen diluted with nitrogen. As the concentration diminished, *i.e.*, as the distance between the electronic orbits of the molecules increased, the specific magnetization coefficient of oxygen became greater. Continued studies of this spatial rela-

[7] Aston, "Isotopes," p. 92 and p. 93, 1922.

[8] Bohr, *Zeit. Physik.*, 9, pp. 1–67, 1922.

[9] Sommerfeld, "Atomic Structure and Spectral Lines," 3d. Ed., 1922.

[10] Young, *Phil. Mag.*, p. 29, August, 1923.

[11] Bohr, "The Theory of Spectra and Atomic Constitution," p. 74, 1922.

[12] Hull, *Phys. Rev.*, p. 540, 1919.

[13] Perrier and Onnes, Proc. Roy. Acad. Amsterdam, 16, 901, 1914.

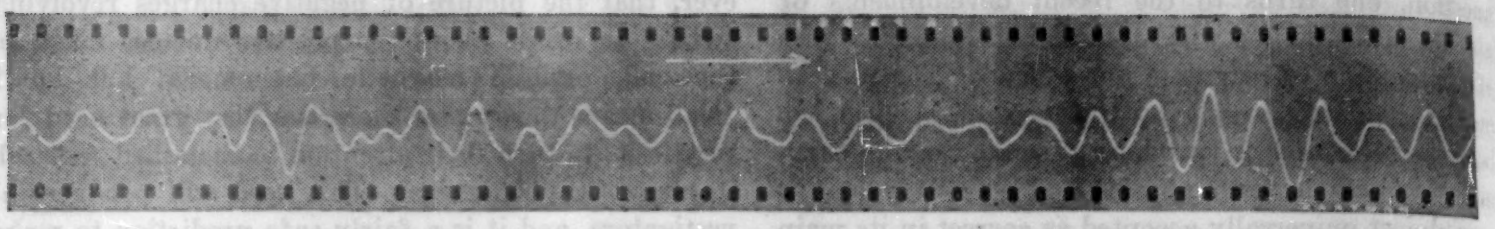

FIG. 1. Oscillogram of Barkhausen Effect.—Arrow indicates direction film moved.—Distance from one perforation to the next indicates 1/509 of a second.

tionship of the electronic orbits in internuclear and intermolecular space must still yield very valuable contributions to our knowledge of atomic structure.

In applying the quantum theory to magnetic phenomena it appears that an atom possessing a magnetic moment and subjected to a magnetic field is not able to orient itself into any position but only at certain definite inclinations, such that the cosine of the angle between the magnetic axis of the atom and the direction of the applied field will have one of certain specified values.[14] Gerlach's[15] work with a ray of silver atoms projected through a magnetic field with an extremely steep field gradient seems to confirm this. If such a point of view is correct would it not indicate that the process of the magnetization of iron, for example, would not be a continuous process but stepwise? An oscillographic study[16] of the Barkhausen[17] effect shows that the magnetization process does proceed by irregular steps and not continuously. The elementary magnets appear to jump in groups, sometimes a great many and at others a few only (see Fig. 1). Is the Barkhausen effect another confirmation of the applicability of the quantum theory to magnetic phenomena? It is an interesting avenue of approach to the study of magnetic phenomena.

Not only will these four specific lines of research in magnetic phenomena be illuminating to the whole field of atomic structure, but the fundamental principle enunciated in the beginning becomes itself a program of research along the same line that must challenge many because of the numerous problems which it suggests.

There are a few items which should be emphasized in connection with research in magnetism. As far as possible the same specimens should be used in all the magnetic tests which may be applied to any substance. For instance, if the magneto-mechanical effects of a steel rod are studied, the same rod should be used in studying the Barkhausen effect in magneto-acoustics, the change in resistance in the next group, its magnetic induction, the effects due to heat and the Kerr effect in the other groups. *The importance of making as many tests as possible on the same specimen can not be overestimated.* Here, if anywhere in scientific research, there must be cooperative action, for the program of research as outlined above will lead into the fields of physics, chemistry, both physical and chemical metallurgy and mineralogy. A group of physicists, mineralogists expert in X-ray analysis, chemists and metallurgists cooperating in the study of magnetic phenomena could make a wonderful contribution to this field. Helmholtz is quoted as having said that "the disgrace of the nineteenth century is its ignorance of the subject of magnetism." Will the twentieth bring knowledge?

There has been a prodigious amount of labor performed in the field of magnetic research. Knowlton[18] counted the papers on the subject of magnetism which had been reviewed in *Science Abstracts* for the decade 1900–1910 and there were about five hundred, exclusive of technical contributions and papers on electromagnetism. *Sustained research, both coordinated and cooperative, is needed in the fields of magnetic phenomena.*

A great deal of work has been done on materials whose chemical properties were not known, to say nothing of the previous physical history which is so important in correlative studies. There is real need to go back and review the experimental data and where possible correlate one set of facts with another, and where no knowledge of the physical and chemical history exists repeat the experiments as far as possible with standard or known conditions. *Modern methods of pyrometry, microphotography, chemical and X-ray analysis give no excuse for ignorance of the character of the materials used in magnetic investigations.*

The magnetic analysis of the physical and chemical properties of matter will lead into many fields that at present are almost wholly unexplored. This is illustrated in that work which has rather recently been undertaken, *viz.*, the study of the mechanical properties of steel by magnetic analysis. In the case of diamagnetic substances the magnetic forces are so feeble that they may be investigated only by very delicate methods. *This difficulty will disappear as the technique of the problem is developed.*

A general study as thus outlined would lead to two very distinct goals: first, it would develop methods of

[14] Darrow, *Bell System Tech. Jour.*, October, 1923.
[15] Gerlach, *ZS.* f. Physik., 9, pp. 349–355; 1922.
[16] Williams, *Phys. Rev.*, p. 526, November, 1923.
[17] Barkhausen, *Phys. ZS.* 20, 401–403, 1919.
[18] Knowlton, *Terres. Mag.*, p. 3, March, 1910.

analysis of immense value to the industrial arts and sciences, and secondly, of even greater significance, a furtherance of our present concept of the structure of the atom.

Now why have I brought to you, my fellow teachers, this rather specialized discussion of research work? In the first place, because it is typical of all modern research work in the physical sciences, it is concerned with the problem of atomic structure in which we are all interested. Secondly, and most important of all, you hold a very strategical position in the program of research in this country in the fields of physics and chemistry. It is given to you, the unique honor of introducing very many of our future research chemists and physicists to their first formal knowledge of the fundamental sciences of chemistry and physics. To you is given the opportunity to inspire these embryo scientists with a love and enthusiasm for the fields of knowledge in which we are so interested. Every hour in the class-room or laboratory is one of golden opportunity to instill in their minds a desire for more knowledge in these fields. We may erect on the highway of knowledge along which these young people travel signboards bearing the words "On to College." That wisdom may be shown in whom we recommend for college and that the proper college be urged to these students needs to be emphasized. Our zeal in recruiting should not run riot. The slogan "On to College" is for those servants which have more than one talent. Beyond the college lies the graduate school. To only a gifted few is the invitation, "Enter thou into the joy of creative scholarship." In the matter of pushing a favorite college it should not be from the standpoint of its being our Alma Mater, unless we are sure that these young people will be furthered on in the divine life of scientific knowledge. They must be recommended to a college which is known for its equipment and scholarly and enthusiastic teachers and not because it happens to have a winning football or other athletic team.

Isn't this hope of being able to contribute to the development of future great physicists and chemists a stimulus to do our own work just a little better than ever before as thus we help young men and women to find their life work? I believe it is.

S. R. WILLIAMS

OBERLIN COLLEGE

EXPERIMENTAL BIOLOGY AND THE WORK OF THE MOSCOW INSTITUTE*

ZOOLOGY of to-day differs greatly from the zoology of the nineteenth century. Two points are characteristic in modern zoological research. First, the chief method of zoology is now experimental and we call our science a branch of experimental biology. Second, during the period of the last ten years all branches of the natural sciences have come to need organization, and experimental biology requires organization more than any other science. The organization of science must be national in the sense that every country will coordinate its own researchers, who must work under the particular conditions which their country may afford, but the work of these national organizations can of course be regulated by international meetings.

I wish to offer many thanks to the American Zoological Society and the Genetics Section for their kind invitations to take part in the meeting at Cincinnati. I am very sorry that circumstances have not allowed me to take part in it personally, as had been my wish, and that I have been compelled to send the report, which I intended to read.

Some of the American biological laboratories have been devoted to determined special purposes. So, for instance, the celebrated laboratory of Jacques Loeb pursues the fundamental problems of the application of physical chemistry to biology, and T. H. Morgan's laboratory is especially devoted to the genetics of Drosophila. But it would be very interesting to unite these two scientific tendencies in the same institution. In every science the best results are to be obtained when the same theme is treated with two quite different methods belonging to two different scientific branches. Therefore, I have tried to put together in my Moscow Institute of Experimental Biology many different sections, such as cytological, biochemical, physiological, behavioristic, genetic and eugenic sections. Sometimes two or more of these sections work on the same subject, but every section investigates the problem from its own point of view and with its own methods.

I

The chief problem of our cytological section is that of the cell-skeleton. In 1905, when studying the structure of the sperm of different crayfishes[1] I came to the conclusion that every cell whose external form differs from the spherical one ought to consist of a drop of liquid protoplasm (hydrosol) and of a hard protoplasmic skeleton (hydrogel), whose form determines the external form of the cell. The rôle of this skeleton is played by the hard cell membranes or by the organic fibers which lie in the outer layer of the protoplasm and define the form of the liquid proto-

* Address sent to the convention of the American Society of Zoologists, upon invitation of the society.—Ed.

[1] N. K. Koltzoff, "Studien ueber die Gestalt der Zelle." Th. I, *Archiv für Micr. Anat.*, Bd. 67; Th. II and III, *Archiv für Zellforschung*, Bd. II and VII.

plasmic drop, as metallic frames (circles, spirals, etc.) define the form of oil drops in the well-known experiments of Plateau. I have found such formative fibers in the spermatozoa of very different animals, in the red blood corpuscles of Amphibia, in connective tissue, etc. In nerve tissue the form of the cell and the nerve fibers is determined by the hard neurofibrils, and their chief function is to be considered as the defining of the external form of the nerve cell. In the contractile cell or cell organ (such as muscle, the stalk of Vorticella, or vibrating cilia), the form of the contraction or vibration is also determined by the hard formative fibrils, while the moving force (such as surface tension) is gotten from the liquid kinoplasm. Experiments on the influence of osmotic pressure, of acids or alkalies, etc., on the living cell, are necessary for distinguishing the liquid from the hard parts of the cell.

In recent years the experimental investigations on the form of the cell have been continued in my Institute by G. I. Roskin[2] on muscle fibers, and by L. S. Peshkovskaia on the various Protozoa. The former has described the muscle-fibers in different Protozoa and Metazoa (Hydra, Ctenophora, Mollusca) and found out that everywhere the contractile fiber consists of a thick hard tube full of the liquid kinoplasm, which under the influence of acids, alkalies, etc., breaks up into minute drops; when this reaction takes place, the contractility disappears. This structure is characteristic for smooth muscle fibers, but as Marcus, continuing our researches, has established, striated muscles can have a similar structure. L. S. Peshkovskaia is studying the "kinostatical" apparatus in different Infusoria. She has published a work on Trichodina and has described a very complex system of intracellular fibers, some of which are undoubtedly hard and determine the external form of the animal, as also the form of its different layers, and some of which are contractile and contain in themselves a complex internal structure. The same kinostatical apparatus is visible in Stylonychia, Bursaria and other Infusoria; in many respects it is identical with the neuro-motor apparatus of Kofoid and his school, but since it is difficult to distinguish whether the fibers in each given case are contractile, "nervous," or formative, I prefer to give it the name "kinostatical apparatus."

The chromosomes appear to us—after the fundamental researches of Wilson upon sex chromosomes and of Morgan's school upon the genetics of Drosophila—as permanent cell-organs. Without doubt they possess a hard skeleton. The investigations of P. I. Shivago suggest the existence of (1) a hard internal stalk ("linin" stalk) in every chromosome, which can grow longer or become shorter, but persists through all stages of the mitotic process and in the resting cell-nucleus; of (2) a more or less thin layer of liquid substance (pyrenin ?), clothing the hard internal stalk and merging (during the telophase) into the pyrenin-nucleoli; and of (3) chromatin corpuscles, which lie regularly on definite points of the hard stalk through all stages of the mitotic process and in the resting nucleus. These chromatin corpuscles appear to be the carriers of heredity, perhaps of groups of genes; the internal hard linin stalk may be a skeleton of the chromosome; and the liquid pyrenin covering acts as a medium of exchange between the chromatin corpuscles and other substances of nucleus or protoplasm.

The genetic investigations, to which we shall refer later on, are accompanied by researches on mitotic division in the same animals. Thus, it has been established by P. I. Shivago that in the somatic cells of fowl there are 15 pairs of autosomes and two sex chromosomes (two X-chromosomes in the male and one X and one Y in the female). The succeeding investigations of P. I. Shivago suggest that the variability in number of chromosomes in different somatic cells of young feathers having a distinctive coloration depends upon the circumstance that they may be deprived of one X-chromosome. Further, S. L. Frolova has described the reduction of chromosomes in Chermes[3] and is studying the number of chromosomes in Russian species of Drosophila. A. O. Tausson has published a (Russian) work on reduction in Asplanchna.

II

The study of the kinostatical structure in the cell brought me to the problem of the action of inorganic ions upon the living cell. Since my published investigations on the influence of K, Na, Ca, Mg, Sr, etc., upon the stalk of Zoothamnium[4] and H (— OH) ions upon phagocytosis in Carchesium,[5] many of my collaborators have been working on this problem, which is so intimately connected with the name of Jacques Loeb. In the meantime we have explored the dependence of the life of different species of Infusoria and of many fresh-water Invertebrates upon the concentration of H-ions and other kations and anions. As a result of these investigations it was established that the concentration of these ions in fresh water determines the fauna and flora of fresh-water tanks to a greater degree than the temperature, the concentration of O_2 and CO_2, etc. At the Hydrobiological Station of the Institute of Experimental Biology under the guidance of S. N. Skadovsky the

[2] Roskin, *Archiv für Zellforschung*, 1923; *Anatomischer Anzeiger*, 1923.

[3] This work has been sent to *Archiv für Zellforschung*.

[4] *Archiv für gesammte Physiologie*, Bd. 149, 1912.

[5] *Internat. Z. für physik-Chem. Biologie*, Bd. I, 1914.

concentration of H-ions has been determined in many different tanks in every season, and the data thus established have been compared with the data on the fauna and flora of each of these tanks in all seasons. The summary of this work of the Hydrobiological Station was reported to the International Limnological Congress at Kiel in 1922 and published in the Proceedings of this Congress. The method and the results of the researches of our Institute appeared new and interesting to the limnologists of Central Europe, and the last Congress of Limnologists at Innsbruck (1923) decided to convoke the next International Congress, in 1925, in Moscow. Professor S. N. Skadovsky was asked to make the general report to the Congress on the significance of the concentration of H-ions to the life in fresh-water tanks.[6]

III

When in 1916 I began the organization of the new laboratory of the Institute of Experimental Biology, great difficulty was encountered in getting in time of war all the necessary instruments for providing a modern physico-chemical laboratory, and we still lack some important apparatus, as, for example, the American potentiometer. In such circumstances we have been forced to concentrate our attention on such problems of experimental biology as may be studied without complex instruments and rare chemical preparations.

In connection with these circumstances I was compelled to lead the most immediate investigatory work of the Institute in two new directions: firstly, surgical experiments, especially in relation to endocrine glands, and, secondly, genetic investigations.

As to the endocrine organs, their study was begun in 1913 by the transplantation of gonads in various amphibians, birds and mammals. I. G. Kogan attempted to transplant the gonads from one frog to another, by way of verifying the Steinach results. M. M. Zavadovsky began his researches upon the transplantation of gonads, which he continued by himself in *Ascania nova* and published in 1922. In 1917, with the assistance of Miss Burdakova, I succeeded in bringing about the experimental metamorphosis of *Siredon* under the influence of thyroidin and we are now studying the comparative morphology of the endocrine system in *Siredon* and *Amblystoma*.

During the last two years I. G. Kogan has been working on the rejuvenation of old guinea pigs and fowl which had ceased to reproduce. We have paid our chief attention to the rejuvenation of females by the transplantation of young ovaries. Many old females of guinea pigs, which for a whole year had had no young, after having gotten a transplanted ovary became gravid in a few weeks and brought forth normal young.

The most interesting experiment with old birds we succeeded in getting from a Faverol hen, which is now seven years old. In the summer of 1921 this hen (5 years old) laid only one egg; in the autumn it received a transplanted ovary from a young hen born in the same year. In the summer of 1922 it laid 16 eggs. In the winter of 1922 another young ovary was transplanted into this rejuvenated hen and in the summer of 1923 it laid 36 eggs; the last egg has been laid on the 30th of October, after all other hens in our menagerie had ceased laying eggs. Very good results have also been obtained in the case of a transplantation of young testicle into an old dog of 18 years. About 150 grafts of sexual glands are now being studied in microscopic sections.

Since the experiments of Przibram's Institute in Vienna on the transplantation of eyes in different adult vertebrates were published in 1922, we have endeavored to verify them. E. E. Trapesonzeva in 80 cases transplanted one frog's eyes to another or cut the optic nerve, replacing the eyeball, which had previously been taken out, in its original position. In many cases the grafts or the eyeballs with the optic nerve cut perished in a few weeks, but in other cases the eyeballs kept their normal aspect and transparency. In seven operated frogs the reaction of the pupil to light, which had disappeared for about a month after the operation, was restored.

In order to ascertain whether the sight of the operated frogs may also be reestablished, two frogs, one of which had kept the pupillary reaction and the other not, were transmitted to the zoopsychological section of the institute to observe their behavior. It was established by M. P. Sadovnikova, by means of a special apparatus, that the frog whose pupils did not react had become insensible to a sudden light, whereas the other one reacted to the light like the normal autumn frogs, by running away to the dark room of the apparatus. As to the form of the object, neither of the frogs showed any receptivity: they did not notice the flies creeping on the walls of their terrarium, but they had developed their touch, as blind animals often do, and learned to grasp the flies sitting on their forefeet, which normal frogs never do.

In the investigation of this problem the cooperation

[6] In connection with the work of this section the following papers also are now ready for publication: (1) W. N. Schroeder: "The significance of the acid reaction of the medium for the life of some Protozoa under anaerobic conditions" (Colpidium, Paramaecium, Volvox, Euglena.) (2) A. T. Iazenko: "The gas exchange of Sphaerium and the function of the mantle-liquid"; (3) A. O. Tausson: "The influence of H-ions and Ca-, Mg-, Na- etc. -ions upon the development and the life-cycle in *Asplanchna intermedia*"; (4) S. N. Skadovsky: "The influence of external conditions on the gas-exchange of the larva of *Chironomus*"; (5) V. I. Uspenskaia: "The influence of quinine on *Spirostomum ambiguum* in the presence of different electrolytes."

of physiological and zoopsychological sections has proved very useful. Other investigations of the latter section, employing the methods of Yerkes, Watson and other American behaviorists, are known in America, because the works of Mrs. Sadovnikova upon her experiments on the behavior of birds in the maze and in the multiple choice apparatus have been published in the *Jorunal of Comparative Psychology* this year.

IV

Our genetic work began five years ago at the Anikovo Station (60 kilometers from Moscow, in the country) annexed to the Moscow Institute. As the first subject of our investigations, quite new in Russia, we have chosen the domestic fowl, especially of two Russian races: Orloff's with nutcombs and Pavloff's with compressed crests and feathered legs; these two races are of very ancient origin and now after the war and the revolution nearly extinct in Russia. We are now about to publish a summary of our investigations (with 15 colored plates and an English résumé) on the genetics of these fowl. Professor Screbrovsky is investigating 40 genes of the fowl and as yet he has not been able to divide these genes into 16 groups, in relation to the number of chromosomes established by Dr. Shivago. That is particularly astonishing, because six chromosomes of the fowl are very small and probably contain but very few genes. Only three genes (*suke, trage* and *tuge*) appear to be correlated and included in the sex chromosome (see *American Naturalist,* 1923). As to the genetics of fowls the following results are to be noticed: intensive search for linkage has not given a single sure case, althouhg a great number of combinations, containing about 20 well Mendelizing genes, has been studied. In some cases perhaps there might be observed a slight linkage (*tifa* and *truklake,* black plumage and white shell; *sune* and *sule,* crest and frizzling; *wele* and *tode,* Y-comb and blue coloration), but the data we possess are too insufficient for insisting on this linkage. In one case, indeed, we have nearly absolute linkage (*sunu* and *gidu*—expanding crest and narrow nostrils), but the single case of breaking between the genes could not be studied in a satisfactory manner. It is true that in fowl the number of chromosomes is very great (32); nevertheless, the absence of linkage is to be explained only by the ease of crossing over, occurring in both sexes. It can be explained in the same way that the three genes, whose mutual positions in the sex-chromosome we succeeded in determining (*suke-tuge-trage*), are giving a very high percentage of crossing over between *suke* and *trage* (about 50 "morganids").

Very interesting observations have been made on the hybrid cocks, heterozygous for two sex-linked genes, *tuge* and *trage* (silver and barred condition). Among the feathers of these cocks, colored as in Plymouth Rocks, feathers sometimes occur whose coloration admits the suggestion that these feathers are deprived of the chromosome (or a part of the chromosome) carrying the genes *tuge* and *trage,* while on the whole the same cocks contain the genes *tuge* and *trage.* We may suppose that in the development of these exceptional feathers some irregularity of mitotic division and the disappearance of the corresponding chromosome has taken place.

The second subject of our genetic investigations was guinea pigs. I have already published the beginning of these experiments: we have found for the first time in Europe the pink-eyed race with diluted color, and a white black-eyed race; the latter transmits its coloration, but not quite regularly. At present Professor Lebedeff is engaged in working out further the problem of the coloration of the guinea pigs, taking into consideration the American researches of Wright, which we did not know of till this year. We have not yet found Wright's long series of allelomorphs, but many of our genes for color in guinea pigs appear to be different from those of Wright. Furthermore, we have obtained some interesting types of coloration after crossing the white rat with the wild Russian gray rat.

The genetic work on Drosophila had already begun in our institute before Professor Muller brought us from America a very valuable present: 32 living races of *Drosophila melanogaster.* We have now published a Russian translation of Morgan's "Physical Basis of Heredity" (translated by Professor W. Lebedeff). Thus we are able to study the genetics of this famous fly on a large scale. The study of the mutations of the Russian species *D. funebris* is being carried on by Professor S. S. Czetverikoff, D. D. Romashov and others. Six mutations have been established more or less precisely in this species: (1) *Abdomen abnormalis*—identical with "Abnormal abdomen" of *D. melanogaster,* selected until they now yield 100 per cent. of abnormal progeny; (2) *Alae naucellae;* (3) *Alae curvatae;* (4) *Alae divergentes;* (5) *N. transversus 2 abnormalis,* and (6) *N. longitudinalis 2 abnormalis.* Mutations (1) and (4) are dominant, the others recessive. Most of the mutations can not be identified with those found in *D. melanogaster.* In *Drosophila transversa* also a new recessive mutant, *Alae divergentes,* has been found by N. W. Timofeew.

All 32 mutations brought by Professor Muller are still living and breeding true, under the chief observation of Professor Serebrovsky. Some new mutations have arisen during this year: (1) White eyed (3 times), (2) eyeless and (3) notch; but not all these mutations are identical with those found in Morgan's laboratory and the corresponding genes probably lie in another place in the same chromosome or in another chromosome.

Recently Professor S. S. Czetverikoff, with the as-

sistance of a group of our younger collaborators, has begun a biometrical study of the variability of characters in the free population of *Drosophila funebris*. The variability of 75 characters in 150 males, taken in the same place, has been studied. This investigation has been made with the purpose of establishing the existence of many distinct types of *Drosophila funebris*, living at the same time in normal communities, and all together to detect the correlation between different groups of characters. As a result of these investigations both questions have received a positive solution, and a further analysis is being carried on to ascertain to what degree the observed variations are of phenotypical or genotypical origin.

F. G. Dobrgansky, who works in Kiev but in intimate connection with our institute, is studying the structure of the genital apparatus in different mutants of *Drosophila melanogaster*. This study has established the very remarkable fact that in most mutations of D. (vestigial, black, etc.) the structure of different parts of the genital apparatus (in male and female) is also modified. This work has been sent for publication in *Zeitschrift für induktive Abst. und Vererbungslehre*.

The connection between two sections of our institution—the genetic and the physico-chemical sections—has evoked the appearance of a series of investigations "on the chemical hereditary properties of blood"; under this title I began to publish the results of these researches. When I and Miss S. S. Elisarova began, according to the method of A. N. Bach, the quantitative determination of the different enzymes in the blood of guinea pigs (catalase, lipase, peroxidase and protease), we found that the contents of catalase in different animals varies greatly: from 3 to 20. The influence of external conditions proved incapable of causing a profound change in the individual index of catalase in a given guinea pig. When we fed an animal (having an index, for instance, of 4) with thyroidin, castrated it or contaminated it with the bacteria of phthisis, the index fluctuated between 3 and 6—no more nor less; in other animals the fluctuations under the same conditions varied between 7 and 14, or between 16 and 20. Therefore, we came to the conclusion that there exist three chief genetic groups of guinea pigs, for each of which the definite index of catalase is characteristic: for group I—the index 3–6, for group II—7–15, for group III—14–21. Having divided all our guinea pigs (more than a thousand) into these three groups, we studied the heredity of corresponding families and established the facts that group I is always homozygous and recessive for "a," with the genetic formula aabb (perhaps also aaBb or aaBB); group II is heterozygous, Aa (with bb or Bb); group III is AA or Aa BB. Most recently, in collaboration with Miss Höptner, we detected another fourth group with index 0–1; this index is also transmitted by heredity and the genotype of this group is now going to be studied.

By some further investigations of Miss N. Savitsh three similar hereditary groups, characterized by their index of catalase, have been established in fowl; but the genotypic formula is here probably quite different. At the Russian Agricultural Exhibition of 1923 in Moscow we determined the contents of catalase in cattle which had been gathered from different parts of Russia from Vladivostok to Archangel and from Samarkand to Odessa. Most of the animals showed an index between 4 and 8.5, but a few (especially Zebu-hybrids from crosses of Turkestan domestic buffalos and cows) gave a much higher index (even 12); thus it may be that in cattle also we have two genetic groups. In sheep the catalase index fluctuates from 0.5 to 4.1, but the greater number of the Romanovsky sheep of Central Russia are characterized by a low index. Investigatory work on the contents of catalase in the blood of human beings of different races is now being carried on.

We are also determining the agglutination of human blood (Miss M. Avdeeva and M. Gryzevicz) and have gotten the four well-known hereditary groups; their distribution is somewhat different in Russians and Jews. Further, we have determined that in subjects suffering from phthisis the distribution of groups differs distinctly from the normal: group IV (whose serum agglutinates all other groups) appears here less often. Thus the probable deduction is that the subjects of group IV possess in a greater or less degree an immunity of phthisis.

A variety of haemagglutination has also been found in fowl and cattle (and perhaps rabbits). Our observations in horses and in some races of cattle (yak, some Caucasus races) have proved that here autoagglutination cases are often to be noticed, and the autoagglutination (occurring in the cooled blood serum of the same animal) appears to be of genetic origin in the race.

We have studied agglutination in members of 100 families, but as group I (having non-agglutinating serum) is very rare, the genotypic analysis can not yet be made definitively; the most probable hypothesis is, that group I is Abc; group II, ABC; group III, ABc, and group IV, a (with either BC or Bc or bc).

V

The Institute of Experimental Biology has also a eugenical section. In connection with the work of this section the Russian Eugenical Society has been founded; I was elected its president, following its inauguration in 1920. In 1922 I was elected by the Russian Eugenical Society as member of the International Commission of Eugenics, officially representing Russia.

The chief aim of the Russian Eugenical Society has

been propaganda for eugenical ideas, which are as yet quite new in Russia. The society has had about 50 conferences and is publishing *The Russian Eugenics Journal*. The scientific investigatory work of the eugenical section of the institute has followed two chief directions: firstly, experimental work in anthropogenetics—the above-mentioned researches on haemagglutination and catalase in man, the classification of the colors of hair by the method of spectrophotometry (Professor V. V. Bunak and G. W. Sobolewa), the genetics of the human hand (M. M. Wolotzkoi), etc.; secondly, the study of the genealogy of some eminent Russian families (thus, Tchulkoff has established the consanguinity of two of the greatest Russian writers, Leo Tolstoi and A. Pushkin, of which Leo Tolstoi himself had not the slightest notion). The institute, together with the Russian Eugenical Society, has organized two eugenical expeditions under the guidance of W. W. Bunak: (1) Into some of the Volga districts for the investigation of miscegenation betwen the Slavish and some Finnish races, (2) into the Minsk district for the investigation of the settled Jews; for the study of anthropogenetical characters of Jews the Russian Eugenical Society has organized a special commission.

Here I have given the picture of the work of my institute. It embraces most of the chief problems of modern experimental biology. The plans of these investigations might perhaps be considered as too large for one laboratory, especially under the unfavorable conditions which Russian science is now going through. It would of course appear more natural to concentrate our whole attention on a single problem. But from the point of view of the organization of science in Russia, it was desirable to unite in the institute many biologists who were interested in various branches of experimental biology; on the other hand, this arrangement has been very convenient for carrying on work in the intermediate regions of our science, in fields in which it is easier to plan new problems despite scanty literature and lack of expensive apparatus. Only thanks to such a variety of sections could we attempt to bring together cytology, limnology and physical chemistry; genetics and biochemistry; transplantation of eyes and zoopsychology, etc. The results of our investigations in each section of experimental biology may be of no great significance; but this collaboration is forming a new generation of Russian biologists, who will carry further the work in the intermediate regions of our science.

Nic. Koltzoff

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TWO UNPUBLISHED MONUMENTS TO AMERICAN SCHOLARSHIP

The assertion that American scholars do not engage in those tasks of scholarship requiring long-continued devotion has been so often made and implied that even Americans are wont to accept the assertion as founded in fact. However, there are now so many published works which refute the above assertion that one may hope that the illusion will vanish.

On a recent trip in search of American arithmetics published before 1800, I chanced upon two monumental undertakings of a fine type of American scholarship which though completed remain unpublished, because of the monumental character of the enterprises.

At the Library of Congress, Phillip Lee Philips, chief of the division of maps, had at his hand in typewritten form 25 volumes comprising a complete bibliography of cartography. The material includes all the literature of cartography which had come to the attention of the author and compiled during some 50 years of service at the Library of Congress. Bibliographical work of this character can rarely, if ever, properly be described as complete. However, as the material in published form would extend over five octavo volumes of about 1,000 pages each it is sufficiently complete so that the work would be of inestimable value to all scholars interested in cartography, historical and practical. Particularly would the work be useful to libraries like the John Carter Brown Library at Providence, the William L. Clements Library at Michigan, the Newberry and the Crerar Libraries in Chicago, the Bancroft and the Huntington Libraries in California, the New York Public Library, and, in short, useful to all libraries that make any serious attempt to collect early maps and atlases of America.

Mr. Philips has to his credit an enduring monument in the List of Geographical Atlases in the Library of Congress as well as numerous monographs on related topics. The Library of Congress catalogue is in four volumes, with a fifth about to be issued. Critical scholars are able to point out in this work certain possible changes which would extend the usefulness of the work. Undoubtedly the same is true of the "Bibliography of Cartography," as it is, indeed, commonly true of similar work in any line of scholarly endeavor. However, neither the "Catalogue of Atlases" nor the "Bibliography of Cartography" could, in my opinion, be produced by the work of any scholar without constant and unremitting attention to the task over a period of many years.

The publication of this material would cost probably ten to fifteen thousand dollars. Congressional action would be necessary to have it issued as a gov-

ernment publication. It is to be hoped that such action may soon be taken. It would, of course, be highly desirable that a group of scholars should edit the work, and collaborate to make it so complete and perfect that American scholars may point to it with the same pride that Englishmen point to "The New English Dictionary."

A second enterprise of the same colossal nature I chanced upon at Princeton University. Professor William Libbey, professor of geography, has for nearly 50 years been engaged in making a card catalogue of the articles in the geographical journals which are in his library. This index includes all the articles which have ever appeared in such journals as Petermann's *Mittheilungen, Journal of the American Geographical Society,* the Royal Geographical Society of London, the journals of the French and German geographical societies, the *Annales de Geographie, Le Globe,* and others of the leading geographical periodicals, totaling over 20 journals. The catalogue is both a subject and author catalogue and includes about 150,000 cards. Any one familiar with scholarly work of this nature will recognize immediately the great usefulness to other scholars of a comprehensive catalogue of this kind. In printed form the catalogue would require four volumes of about 1,000 quarto pages each, and would cost approximately $20,000.

One can not measure achievements such as these in dollars and cents. Such works can properly be compared only with great works of art and monumental engineering enterprises. The courage which enables a man to carry through such a disinterested task for the general welfare of science deserves recognition and especially the recognition of publication by some American organization.

LOUIS C. KARPINSKI

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ALEXANDER DYER MacGILLIVRAY

IN the death of Professor MacGillivray, which occurred at Urbana, Illinois, March 24, science has lost one of its most devoted and sincere workers and education one of its most efficient teachers. He was born at Inverness, Ohio, July 15, 1868. In 1889 he came to Cornell University, intending to take a special course in entomology, as he had already made a collection of insects and given this subject enthusiastic boyish study. Acting on the advice of the writer he modified his plans, prepared for and entered the university as a regular student, and graduated with the degree of Ph.B. in 1900. In 1904, he received the degree of Ph.D. While an undergraduate he assisted in the entomological laboratory and on graduation was made instructor in entomology. Later, he was advanced first to the rank of assistant professor and then to that of associate professor. He remained at Cornell till 1917, when he became professor of systematic entomology in the University of Illinois, which position he held until his death.

From the beginning of his teaching he showed the qualities of a thorough teacher. Although very gentle and quiet in manner, he insisted upon a perfection of knowledge on the part of the student that made him preeminent in preparing the student for future work by giving him a solid foundation. He was painstaking and patient but exacted excellence in scholarship. Many of the present generation of workers in entomology owe much to him for the training that he gave them.

Although never very strong physically, in addition to his work as a teacher he was a productive investigator, publishing many papers on systematic entomology. He also inspired and directed the preparation of important papers by his students, notably several of the "Illinois biological monographs."

In 1891, he married Fanny M. Edwards, of Forest Home, New York, and the generous hospitality of their home has been shared by many students. Mrs. MacGillivray and two sons, Malcom and John, survive him.

The death of Dr. MacGillivray is a great bereavement to the writer, for through long years of association with him I found him most lovable in character and most helpful as a colleague.

J. H. COMSTOCK

SCIENTIFIC EVENTS

THE PACIFIC SCIENTIFIC CONGRESS

PRELIMINARY steps have been taken in preparation for the Pacific Scientific Congress to be held in Japan in 1926. Prince Kotihito Kanin has been nominated for president and Premier K. Kiyoura, Minister of Education Egi, and Minister of Foreign Affairs Matsui have been appointed honorary presidents. The committee on preparation consists of fifteen persons headed by Dr. J. Sakurai. Other officials of the congress include professors of the Tokyo Imperial and Waseda Universities. The conference will be held at the Imperial University, Tokyo.

A sum of approximately $100,000 has been allotted for excursions and for the entertainment of delegates. Like the conference in Honolulu (1920), organized by the National Research Council, and the Congress in Melbourne and Sydney (1923), under the auspices of the Australian National Research Council, the organization and direction of the congress in Tokyo is a feature of the activities of the National Research Council of Japan.

The scope of the forthcoming congress embraces the field of physical and natural science. The primary purpose is to discuss the problems relating to

the Pacific region and to make provision for international cooperation in the solution of such problems as food conservation, development of agriculture and welfare of the native races.

It is expected that announcements regarding program and routes of travel will be made within the next few months, with a view to giving universities, scientific institutions and prospective delegates ample time for making arrangements. It is probable that provision will be made in Honolulu for the entertainment of delegates to the congress who desire to visit Hawaii.

PUBLIC HEALTH SUMMER SCHOOLS

SURGEON-GENERAL H. S. CUMMING has issued the following statement to physicians and sanitarians:

In one capacity or another, directly or indirectly, you are engaged in combating preventable diseases which will cost the people of the United States this year over 3,000 millions of dollars, cause inestimable suffering and result in approximately 500,000 deaths.

Certain phases of preventive medicine are developing slowly, with consequent loss of health and life, primarily because adequately trained men and women are not available. In other fields of public health work the personnel has increased so rapidly that there are many at work who have not had the opportunity for training which they desire.

To meet in some measure this emergency, Public Health Summer Schools will be conducted this year (at the suggestion of the United States Public Health Service) by Columbia University, the University of California, the University of Iowa and the University of Michigan. Here all those now engaged in public health work and all planning to have a part in preventive medicine may get intensive, systematic training under leading specialists.

The announcements of the Public Health Summer Schools are now ready and may be obtained upon application. Requests should be sent directly to the universities.

Those in charge of the public health courses are at Columbia University, Dr. Haven Emerson; at the University of California, Dr. John M. Force; at the University of Iowa, Dr. Don M. Griswold, and at the University of Michigan, Dr. John Sundwall. The session at Columbia will last from July 7 to August 15, at California from June 23 to August 2; at Iowa from June 9 to June 18; at Michigan from June 23 to August 2. Certain courses at Michigan will continue for two additional weeks.

AWARDS OF THE ELLIOT MEDAL

AT the recent meeting of the National Academy of Sciences three awards of the Elliot Medal were made on recommendation of the committee after the submission of upwards of 20 monographs for the three years concerned:

Dr. Bashford Dean, the medalist of 1921, has been engaged for 21 years on his three-volumed "Bibliography of the Fishes" with the collaboration of some of the most eminent ichthyologists in the country. The tribute to this volume is by Professor J. Graham Kerr, of the University of Manchester, England.

This volume forms the final instalment of one of the most important contributions to zoological science which has been made in recent years. The science in question appears at the present time to be undergoing a slow but none the less effective process of asphyxiation; it is being gradually smothered under accumulated masses of detail. The researcher, finding himself more and more "unable to see the wood for the trees," tends in despair to desert his real task of helping to develop the general ideas of his subject, for the far easier one of the indiscriminate collection and publication of still additional detail. The more able type of potential recruit to the ranks of zoological investigators is, on the other hand, apt to be held up on the threshold and to have his enthusiasm checked and chilled by his glimpses of the fact-collectors at work. The great Bashford Dean Bibliography will do a really important service to the section of zoology with which it deals by helping to counteract the harmful influences just indicated, inasmuch as it will form an admirable guide to the investigator and learner through the otherwise impenetrable labyrinth of detail.

Dr. William Morton Wheeler, of the Bussey Institution, Harvard University, is the most eminent living student of the ants, as well as the dean of American naturalists. He received the award for his volume of 1922 "Ants of the American Museum Congo Expedition," a book of 1,139 pages, 45 plates, 47 maps and 102 text figures, which not only shows the ants' life of Africa, but present a reclassification of these insects. The tribute accompanying the award is by Dr. Frank E. Lutz, curator of ants in the American Museum of Natural History.

Professor William Morton Wheeler's genius, combined with more than twenty years of intensive study of the taxonomy and habits of ants, has made possible the "Ants of the American Museum Congo Expedition, A Contribution to the Myrmacology of Africa." This work done with the collaboration of J. Bequaert, I. W. Bailey, F. Santschi and W. M. Mann, is not merely a splendid addition to our knowledge of these interesting creatures; it is among the best contributions to general biology.

The ants of the Congo are described in full and critical detail; there are synonymic lists of the ants of the Ethiopian and Malagasy regions; and there are extremely valuable keys to the genera and sub-genera of the ants of the whole world. Of more general interest are the sections dealing with problems of geographic distribution and habits, including the social condition and the interrelations between ants and their living environment—plants, enemies and "messmates."

By unanimous consent of the paleontologists of

America, the award of the medal of 1923 was made to Dr. Ferdinand Canu, paleontologist and paleographer, of Versailles, France, for his volume on "North American Later Tertiary and Quaternary Bryozoa." The address was made by Secretary Charles D. Walcott, secretary of the Smithsonian Institution.

The monograph of "North American Later Tertiary and Quaternary Bryozoa," a quarto volume published by the U. S. National Museum in 1923 with two similar volumes on the Early Tertiary Bryozoa issued in 1920 marks the culmination of the scientific work of Monsieur Ferdinand Canu in the fields of biology and paleontology. This work undertaken at the beginning of the war, at the request of the United States Government, was carried on by Monsieur Canu during the years of the war and thereafter, under most trying circumstances, and at personal sacrifices until its completion was accomplished and his obligations were fulfilled. It was ever his thought that the successful completion of the work would redound to the honor of France and would promote the entente cordiale. Monsieur Canu is therefore that type of scientific man who not only accomplishes results for science at personal sacrifice but also feels that it is his patriotic duty to carry on under untoward conditions.

The value of his work upon fossil and recent bryozoa lies in the fact that, unlike most students, who described these animals mainly from the exterior patterns they secreted, he determined the relationship between the anatomy of the living animal and these outer calcified structures. In doing this he has been able to build up a natural classification in place of the wholly artificial one formerly employed. These studies have led also to new principles of classification, evolution, ecology and other broader aspects of the subject so that a fragmentary bryozoan, fossil or recent, may now reveal to the experienced student many more facts than its position in the scheme of classification. This result of Monsieur Canu's work has proved of great stratigraphic benefit, especially since the smallest fragment from drillings, for example, can be correctly classified and thus used to determine the underground stratigraphy. His work, therefore, is not only valuable to the biologist and paleontologist but also to the practical geologist.

THE NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

THE Board of National Research Fellowships in the Biological Sciences met on April 23 and made the following appointments and reappointments for the year 1924–25:

Reappointments	*New Appointments*
E. G. Anderson, botany	E. F. Adolph, zoology
L. R. Cleveland, zoology	J. A. Faris, botany
Herbert Friedmann, zoology	Marie A. Hinrichs, zoology
R. T. Hance, zoology	N. D. Hirsch, psychology
Melville J. Herskovits, anthropology	J. Q. Holsopple, psychology
Leigh Hoadley, zoology	J. H. Hoskins, botany
E. F. Hopkins, botany	C. R. Hursh, botany
Marian Irwin, botany	Carney Landis, psychology
A. J. Riker, botany	H. S. Liddell, zoology
A. A. Roback, psychology	Wm. Siefriz, botany
F. B. Wann, botany	Lee Travis, psychology
A. Weinstein, zoology	R. H. Wetmore, botany

A second meeting of the board to consider additional applications for the year 1924–25 will, in all probability, be held the first week in September. Applications for action at this meeting should be filed by August 1. Information and application forms may be obtained from the Secretary, Board of National Research Fellowships in the Biological Sciences, National Research Council, Washington, D. C.

These fellowships are supported by a contribution of the Rockefeller Foundation and are administered by a special Board of National Research Fellowships in the biological sciences, appointed by the National Research Council. The fellowships are open to citizens of the United States and Canada who possess a Ph.D. or its equivalent. They are intended for candidates in the earlier years of post-doctorate work, and are designed to recruit men and women as leaders of research in the universities and research establishments of the United States and Canada.

The basic stipends awarded are $1,800 for unmarried fellows and $2,300 for married fellows per annum. These stipends may be increased when there are other dependents or for other cogent reasons.

The fellowships are not granted to any institution or university, but the choice of place to work is left to the fellow, subject to the approval of the fellowship board. The appointments are for full time and no other remunerative or routine work is permitted, except that during the college year the fellows may, by written permission of the board, give a portion of their time, in general not more than one fifth (outside preparation included), to teaching of educational value to themselves, or to attendance on advanced courses of study.

The particular individual with whom a fellow wishes to work should, ordinarily, have agreed to accept him, prior to the consideration of his application by the board. It is further required that the fellow be charged no fees or tuition by the institution where he chooses to work.

F. R. LILLIE, *Chairman*,
Board of National Research Fellowships in the Biological Sciences

THE SMITHSONIAN INSTITUTION AND THE NATIONAL ACADEMY OF SCIENCES

AT the April meeting of the National Academy the following resolution was passed:

Resolved, That, on the occasion of the removal of its offices from the Smithsonian Institution to its new building, the National Academy of Sciences gratefully expresses its obligations to the Secretary and the Board of Regents of the Smithsonian Institution for the courtesies extended for over half a century through the housing and care of the academy records and library, through its cooperation in the conduct of academy business, and through its effective aid in promoting the objects of the academy; and

Resolved, That, the academy expressly acknowledges its high esteem and thanks to the secretary of the Smithsonian Institution, Charles Doolittle Walcott, for his personal interest in the welfare of the academy, his unfailing interest in and attention to the work of the academy in the advancement of science, and his distinguished services as treasurer, vice-president, acting president, president and member of the council and committees, both official and unofficial, in its behalf.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM F. DURAND, professor of mechanical engineering at Stanford University, has been nominated for president of the American Society of Mechanical Engineers.

FARLEY OSGOOD has been elected president of the American Institute of Electrical Engineers.

DR. L. R. JONES, professor of plant pathology of the University of Wisconsin, has been chosen an honorary member of the British Association of Economic Biologists.

PROFESSOR ROBERT A. MILLIKAN, director of the Norman Bridge Laboratory of the California Institute of Technology, arrived on May 25 at Stockholm, where he went to deliver the lecture in connection with the award of the Nobel prize in physics.

THE University of Arizona conferred the degree of doctor of science on Dr. J. McKeen Cattell after he made the commencement address at Tucson on May 28.

PROFESSOR HANS OSCAR JUEL (Upsala), Dr. Hans Spemann (Freiburg) and Dr. Johannes Schmidt (Copenhagen) have been elected foreign members of the Linnean Society of London.

DR. LUDWIG BIEBERBACH, professor of mathematics at the University of Berlin, has been elected a member of the Prussian Academy of Sciences.

THE council of the British Institution of Civil Engineers has made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1923–24: A Telford Gold Medal to Professor C. E. Inglis (Cambridge), Watt Gold Medals to Mr. H. N. Allott (Manchester) and Mr. S. L. Pearce (Manchester), Telford premiums to Mr. A. J. Martin (London), Dr. H. E. Hurst (Cairo) and Mr. D. A. F. Watt (Cairo), Dr. H. Remfrey (Calcutta) and William Burnside (Glasgow); a Crampton Prize to Mr. T. R. Nolan, B.E. (Chittagong), and a Manby Premium to Mr. H. T. Tudsbery (London) and Mr. A. R. Gibbs (London).

PROFESSOR E. MELLANBY, professor of pharmacology in the University of Sheffield, has been awarded the Stewart Prize of the British Medical Association for his discoveries on the relation between rickets and dietetic deficiency.

THE Austrian Anti-Cancer Society has awarded its 1923 prize to Dr. Lipschütz for research into the origin of experimental tar cancer of the mouse, and to Dr. Nather, of the surgical clinic in Vienna, for research into the pathology and therapy of carcinomatous diseases.

A COMMITTEE is collecting funds to publish the monographs of Professor E. Pinerúa, who retires from the chair of chemistry at the University of Madrid this month, having reached the age limit.

DR. C. D. PERRINE, director of the Argentine National Observatory at Cordoba, has been appointed delegate of the Argentine Government to the third Pan-American Scientific Congress which convenes in Lima on November 16.

DR. NILS H. HEITMAN, chief tuberculosis officer of the Norwegian government, and Dr. Germund Wirgin, professor of hygiene, University of Upsala, Sweden, recently arrived in the United States, at the invitation of the Rockefeller Foundation, to study public health work in various cities.

PROFESSOR REGAUD, of the Radium Institute of the University of Paris and of the Curie Foundation, will be the guest of honor with Drs. Howard A. Kelly, Baltimore, and James Ewing, New York, at the banquet of the American Radium Association on June 9.

DR. GILBERT WALKER is retiring from the director-generalship of Observatories of the Indian Meteorological Department, which he has held for twenty years. He will be succeeded by Mr. J. H. Field.

PROFESSOR DIETRICH, of the University of Berlin, has been appointed director of the medical department of the Prussian Ministry of Public Welfare.

THE Committee on Scientific Research of the American Medical Association has awarded a grant of $200 to Dr. Reynold A. Spaeth, associate professor of physiology at the School of Hygiene and Public Health of the Johns Hopkins University, to further his investigation of the relation between physical condition and natural resistance to infection.

THE Boston Society of Natural History has this year awarded its annual Walker prizes in natural history as follows: a first prize of $100 to Miss Maxy Alice Pope, of the department of botany of the University of Colorado, for her essay on "Pollen morphology as an index of relationship"; and a second prize of $50 to Dr. J. P. Kelly, of the department of botany of the Pennsylvania State College, for his essay entitled, "Variable dominance in phlox."

FRANK D. KERN, dean of the graduate school and professor of botany in the Pennsylvania State College, has been granted leave of absence to accept an invitation from the Porto Rican government to study and collect fungi in their domain during the coming summer.

VILHJALMUR STEFANSSON arrived in Sydney, New South Wales, on May 27. He was welcomed by delegates of the Royal Society. Mr. Stefansson plans to explore uncultivated regions of Australia to ascertain the possibility of their development.

ROY CHAPMAN ANDREWS, of the American Museum of Natural History, sailed for Peking on May 25, to spend the year in organizing an expedition to the interior of Mongolia and Central Asia to search for prehistoric remains.

NEIL M. JUDD, head of the expedition of the National Geographic Society to Pueblo Bonito, New Mexico, left Washington on June 4 to begin the fourth year of exploration. More than 300 of the 800 rooms of the ruins have been cleared and many kivas, or circular ceremonial chambers, have been brought to light.

DR. FRANK R. LILLIE, of the University of Chicago, gave two lectures on the biology of sex, at the Kansas State Agricultural College, on May 16 and 17, and at a luncheon attended by the workers in biology he described the fellowships in biology of the National Research Council as they are administered by the committee of which he is chairman.

DR. CHARLES H. MAYO, of Rochester, Minn., gave the address at the opening of the first Municipal Cancer Clinic by the Department of Public Welfare, of New York City, on May 26.

AT the meeting of the National Tuberculosis Association held at Atlanta, Georgia, Dr. William Snow Miller, of the University of Wisconsin, opened the symposium on "Endothelium." For the past three years Dr. Miller has been engaged in special research for the association, the results of which were reported at the meeting.

THE Linacre Lecture was delivered by Sir Charles Sherrington, P. R. S., professor of physiology at the University of Oxford, on May 6. The title of the lecture was "Problems of muscular receptivity."

PROFESSOR D. M. S. WATSON delivered the Croonian Lecture of the Royal Society on May 29, taking as his subject "The structure, evolution and origin of the Amphibia."

A COURSE of four free public lectures on the "Astronomers of four centuries"—Tycho Brahe, Edmund Halley, William Herschel and Edward Emerson Barnard—was recently delivered by Mr. A. R. Hinks, at Gresham College, London.

PROFESSOR V. BJERKUES, of Bergen, opened a discussion before the Royal Meteorological Society in London on "The formation of cyclones" on May 12.

DURING the course of lectures by Professor Ehrenfest at the California Institute of Technology, the meetings of the Astronomy and Physics Club of Pasadena were suspended except on February 15, when Dr. Harry F. Reid, professor of geophysics at the Johns Hopkins University, spoke on "The planetesimal hypothesis." The regular sessions were resumed on April 18 when Dr. Henry N. Russell gave a lecture on "The structure of complicated spectra," followed by Dr. R. C. Johnan, on April 25, on "Weak quantization"; by Dr. P. W. Merrill, on May 2, on "The position of red stars in the stellar sequence"; by Dr. N. W. Cummings, on May 9, on "The effect of radiation, wind and humidity on evaporation from water surfaces"; by Dr. H. L. Vanderlinden, on May 16, "Einstein's and DeSitter's cosmological worlds," and by Dr. John A. Anderson, on May 23, on "The torsional seismograph."

THE Alexander Dyer MacGillivray collection of Tenthredinoidea has been purchased by the University of Illinois. The collection includes more than 400 types and about 1,000 species.

A MEMORIAL seat to Gilbert White, erected by the Gilbert White Fellowship, was unveiled at Selborne, Hampshire, by Lady Prain, on May 10. The event was made the occasion of a pilgrimage to Selborne.

IN memory of Emil Zuckerkandl, the anatomist, who for years was a leading member of the Vienna medical faculty, a statue was recently unveiled in the hall of the university. It represents him in the act of explaining to his audience the function of a human joint.

DR. WILLIAM JAMES BEAL, for forty years professor of botany in the Michigan Agricultural College, died on May 12, aged ninety-one years.

PROFESSOR S. G. SHATTOCK, F.R.S., professor of morbid anatomy in the University of London, and pathological curator of the Royal College of Surgeons, died on May 11, aged seventy-one years.

THE twelfth annual meeting of the Eugenics Re-

search Association will be held at Cold Spring Harbor, Long Island, on June 14. The Honorable Albert Johnson, chairman of the Committee on Immigration and Naturalization of the House of Representatives, will deliver the presidential address on "The national immigration policy."

THE Pi Mu Epsilon mathematical fraternity celebrated the decennial anniversary of its founding by installing a chapter at the University of Illinois on May 24, 1924. Professor E. D. Roe, of Syracuse University, was present. This fraternity has now seven chapters.

THE Paris Society of Biology and affiliated societies throughout France opened in Paris on June 5.

THE International Tropical Health Conference will be held in Kingston, Jamaica, during the month of July, under the auspices of the United Fruit Company. The company has invited a large number of American and foreign guests, most of whom rank as leading authorities on tropical diseases, sanitation and related matters, more than fifty of whom have already accepted. The itinerary provides for a brief stop at Havana, a stay of about ten days in Jamaica, a short visit to Guatemala, including the Cuirrigua Ruins and the city of Guatemala, a short stop at different points in Honduras and a fairly prolonged stay on the Isthmus of Panama.

IN connection with the announcement of the proposal to make the Botanic Garden of Harvard University a testing ground for all the hardy herbs siutable for culture in that region with such greenhouse materials as the range can accommodate, invitations to a private view of the garden have been sent out to those interested in horticulture, for the afternoon of June 11, from 3:30 to 7 P. M. The working force of the Botanic Garden will be on hand to exhibit and explain the collections of growing plants. The director, Mr. Stephen F. Hamblin, with Dr. Benjamin L. Robinson, Asa Gray professor of systematic botany, and Professor Merritt L. Fernald, will also be in attendance to assist in showing the development of the garden and the plan for its future. The Harvard Botanic Garden, covering seven acres, was founded in 1807 and is one of the oldest scientific departments of the university.

PRELIMINARY figures issued by the Bureau of the Census show that the birth rates for 1923 were lower than for 1922 in 21 of the 27 states for which figures for the two years are shown in the following summary. The highest 1923 birth rate (34.8 per 1,000 population) is shown for cities of Wyoming and the lowest (15.6) is for rural districts of Montana. Death rates for 1923 were slightly higher than for 1922 in 25 of the 36 states shown for both years. Three states, Connecticut, New York and North Carolina, have the same rates for 1923 as for 1922, and eight states, Colorado, Idaho, Montana, Nebraska, Oregon, South Carolina, Utah and Washington, have lower rates in 1923. The highest 1923 death rate (20.3 per 1,000 population) is shown for cities of Mississippi and the lowest (6.5) for the rural districts of Idaho. Infant mortality rates for 1923 are generally higher than those for 1922, as 17 of the 27 states show higher rates in 1923. The highest 1923 infant mortality rate (117) appears for cities of South Carolina and the lowest (51) for the rural districts of Utah and the cities of Washington. Infant mortality rates are shown for both years for 45 cities of 100,000 population or more in 1920. For 25 of these cities the 1923 infant mortality rates are lower than those of the previous year. The highest 1923 rate (110) is for Richmond and the lowest (48) for Spokane.

WE learn from the *British Medical Journal* that the Royal College of Physicians of London has determined to take a step which changes in the practice of the secondary schools must sooner or later have rendered inevitable. The by-laws prescribe that a candidate for the membership shall satisfy the Censors' Board of sufficiency of his or her general education and acquirements in general science and literature. This has hitherto been interpreted to include a working knowledge of Latin, and it has been optional for candidates to submit themselves for examination in Greek, French or German. At a recent meeting of the college it was resolved that in future candidates should be informed that the languages are not compulsory, but that credit will be given to those who show knowledge in these subjects.

THE Wellcome Foundation, Ltd., has recently been registered as a private limited company, with a capital of £1,000,000, to acquire from Mr. Henry S. Wellcome the business of Burroughs, Wellcome and Co., and the various scientific institutions founded and owned by Mr. Wellcome, who will be the governing director during his life. The foundation has been established entirely for private and family reasons, and the business will be conducted on the same lines as heretofore.

WE learn from *Nature* that the British Science Guild has recently inaugurated a science news service, to which a number of lay journals have subscribed. It is intended that the service shall provide a weekly signed article dealing with some subject of special interest and a weekly column of science notes. It will also furnish reports of scientific progress. The guild is asking for correspondents in the various laboratories throughout the country, in order that it may be possible to keep the

public informed of the work that is being done by British men of science.

THE session of the General Council of Red Cross Societies met in Paris during the first week of May. Among the questions dealt with was that of the development of the international course in public health nursing at the Bedford College for Women, London, which had attracted nurses from Red Cross Societies in thirty-four countries. Mlle. Masarykova, on behalf of the Czecho-slovak Red Cross Society, promised a grant of 50,000 francs towards the establishment of a home for nurses who attend this course. Mr. J. B. Payne, for the American Red Cross Society, promised a grant of 500,000 francs for the same purpose and the British delegate stated that his society would also contribute.

THE Experiment Station *Record* states that experiments in sheep breeding conducted for a third of a century by Dr. Alexander Graham Bell on his Nova Scotia estate are to be continued by the station under an arrangement just completed with Dr. Bell's heirs. The agreement will make it possible to combine Dr. Bell's extensive work on Cape Breton Island, continuing from 1890 almost to the time of his death, with the extensive studies in progress for the last fifteen years by the New Hampshire Agricultural Experiment Station. Dr. Bell was particularly interested in developing a more prolific breed of sheep and in increasing the milk yield of the ewes so that they could suckle more lambs. It is estimated that he had expended nearly $250,000 on this work, and he had attained considerable success in developing a flock with a very high percentage of twin bearers and with from four to six functional nipples instead of two. The station has been investigating sheep breeding as an Adams Act project, crossing different breeds with a view to determining the closeness with which the characters of hybrids are fixed, in the endeavor to produce a sheep that would combine some of the best features of the wool and mutton types and would be particularly profitable under New England conditions. Under the terms of the agreement the Bell estate will present to the station this fall five ewes and one ram, all of the four to six nipple strain, and all from either a twin or triplet progeny. The animals will be crossed with some of the station sheep, the records of which show a ewe that has produced consecutively five sets of twins and one of triplets, while fifteen additional ewes have produced from two to four twins and no singles. Since the profits in sheep raising come from the lamb crop even more than from the wool, the possibilities in this field are apparent. What has not been generally realized, however, is that the milk yield of the ewes must be developed in order that twin or triplet lambs should not have a stunted growth. This was a firm belief of Dr. Bell and has been emphatically shown by the station experiments.

AN experiment which began in Norfolk recently will, according to the London *Times*, be watched with interest by ornithologists. For 20 years Miss E. L. Turner, F.L.S., has spent each summer on an island in the middle of Hickling Broad, which was previously occupied by E. T. Booth, also widely known as an ornithologist. Mr. Booth, however, relied on his gun for securing specimens; Miss Turner has secured much more wonderful records with a camera. She has photographed the home life of the bittern, the reeve, the bearded titmouse, the great crested grebe and of almost all the Broadland residents, and has visited the Dutch meres and marshes, the Farne Islands and many other famous British breeding stations for birds. In the first week of April Miss Turner began a period of service as bird-watcher on Scolt Head Island for the Norfolk Wild Birds Protection Committee. She is residing in a bungalow, which has been presented by Mr. A. W. Cushion, of Norwich, and erected on a plateau halfway up the highest group of sand dunes. Probably for a considerable part of the season she and a companion will be the only residents on the island. Food, letters and newspapers will be taken daily to the island by boat from Brancaster Staithe, and Miss Turner will be able to devote her time to the observation, recording, photographing and protection of the birds that nest on the island. The protection given last year had very encouraging results, and it is hoped that the number of breeding birds and species will be augmented this year. It is hoped that Miss Turner will be able to observe the autumn migration on the island, as its connection with this great movement is quite unknown.

UNIVERSITY AND EDUCATIONAL NOTES

THE General Education Board has given $180,000 to the new Medical School and Hospital of the University of Colorado, now under construction in Denver, and Mrs. Verner Z. Reed, of Denver, has contributed $120,000. The gift from the General Education Board is in addition to its gift of $700,000 made to the construction fund several years ago.

MRS. ELLEN COBB THORNE has given $250,000 to Northwestern University for a memorial to her husband, the late George R. Thorne.

NEGOTIATIONS are in progress to effect a merger of Western Reserve University with other institutions of Cleveland, Ohio, to form a University of Cleveland. These include the Case School of Applied Science, the Cleveland School of Education, the Cleveland Museum of Natural History, the Cleveland School of Art, the Cleveland Museum of Art, the Western Reserve Historical Society Museum, the Lakeside Hospital, the Maternity Hospital and the Babies' Hos-

pital. It is planned to raise an endowment fund of twenty million dollars. The ceremonies in connection with the inauguration of Dr. Robert E. Vinson as president of the university will take place on October 9, 10 and 11.

SIR WILLIAM MULOCK has been unanimously elected to succeed the late Sir Edmund Walker as chancellor of the University of Toronto.

DR. GRAHAM EDGAR, professor of physical and applied chemistry in the University of Virginia, has resigned to join the staff of the research division of the General Motors Corporation.

DR. GEORGE K. K. LINK, who for a number of years has been an investigator in market pathology in connection with the U. S. Bureau of Plant Industry, has been appointed associate professor of plant pathology at the University of Chicago.

AT the Washington University School of Medicine appointments have been made as follows: Dr. David Preswick Barr, assistant professor of medicine at Cornell University, professor of medicine; Dr. Stephen Walter Ranson, professor of anatomy and head of the department of anatomy at Northwestern University Medical School, professor of neuro-anatomy, and Dr. Arthur Isaac Kendall, professor of bacteriology and dean of the Northwestern University Medical School, professor of bacteriology and hygiene.

DR. O. RECHE, of Hamburg, has been appointed professor of anthropology at the University of Vienna, which has been vacant since the death of Professor Pöck two years ago. At the University of Graz, Dr. Otfried Müller, of the University of Tübingen, has accepted the chair of anatomy which had been vacant for many years, and Professor Alfred Wegener, director of the meteorological division of the naval institute in Hamburg, has been appointed professor of meteorology.

DISCUSSION AND CORRESPONDENCE

THE RECENT DISCOVERY OF PLATINUM IN SOUTH AFRICA

DR. PERCY A. WAGNER, of the South African Geological Survey, has just sent me a copy of *Industries Bulletin* No. 101 of the survey, on "Platinum in the Waterberg district," prepared by himself and Tudor G. Trevor. As this gives full details regarding this recent much-heralded discovery, an abstract of the bulletin will be of interest.

The deposit is some 90 miles north of Pretoria and ten miles from the railroad to Pietersburg. The prevailing country rock is a felsite interspersed with a felsite tuff, and underlain by a granite which bears an intrusive relation to it. While in places this granite is exposed, at the principal platinum workings it is probably 500 feet beneath the surface. There are many later faults in the region, and the main platinum lode occupies one of them.

This main lode can be traced at the surface without a break for a distance of two and a half miles, and the best assays have been obtained from a branch of this lode. The lode is described as a quartz-impregnated fault zone, ranging from six to 28 feet in width, with poorly defined walls as a rule. The richer branch lode is from two to five and a half feet in width and is roughly parallel to the main lode and seems to be a branch fissure, rather than a fault. The lode filling varies much in character, but often consists of numerous quartz stringers separated by strips of felsite, sometimes of considerable width. More commonly the lode matter is conspicuously brecciated, angular fragments of pink felsite and of earlier-formed quartz combs or patches of specularite or hermatite lying in a matrix of later white quartz interspersed with druses, and invariably exhibiting a comby or radial-fibrous structure. There must have been several periods of brecciation and quartz deposition, and the quartz deposition and brecciation were evidently very closely connected, at least four generations of quartz being present.

In places the lode matter presents a bright green color, or is banded or streaked with green, owing to the presence in considerable amounts of a leek-green chromium mineral, evidently a chlorite. Nickel and copper were tested for with regative results, but one sample of the ore, containing perhaps 10 per cent. of the chlorite, gave 0.40 per cent. Cr_2O_3.

The platinum is rarely visible in the ore, but can be recognized by a lens. The individual grains range from 0.015 to 0.5 mm in diameter, and clearly belong to an early stage of the mineralization. It is frequently observed in intimate growth with specularite, being often enclosed in that mineral. It also occurs intergrown with quartz, and sometimes coated with secondary oxide, which makes it possible that at greater depths it will be found intergrown with or imbedded in pyrite. The later white quartz is probably barren of platinum.

The platinum bullion runs from 20 to 40 per cent. palladium, and sometimes contains small quantities of iridium, but this is often absent. The other metals of the platinum group have not been found, unless possibly traces of osmium. There is no evidence of iridosmium. Careful search was made for sperrylite, but none was found, nor has gold been recognized.

Cuts and shafts have been sunk to depths ranging from 12 to 40 feet, and have revealed the fact that the platinum is very unevenly and erratically distributed through the lodes, and that the rich ore is confined to shoots. The richest ore thus far opened is

in the branch lode, which has in places given very rich values. A general sample over a width of three feet assayed over 9 ounces per ton, another over 12 inches adjacent to this gave 137 ounces, while a picked specimen ran 173 ounces. Samples taken about every foot in depth across the lode to the depth of 10 feet ran from a trace to 17 ounces, with an average of three ounces. The sample at 10 feet carried about five ounces. Other samples for a distance of 480 feet along the lode show platinum in workable quantities.

On the main lode outcrop samples of 20 inches across the lode for a distance of 50 feet gave an average of over four ounces, at three feet down over 48 inches 0.25 ounces, and at four feet down over 60 inches 1.2 ounces. Farther on a sample over three feet ran 1.35 ounces, while another sample from different parts of the trench gave 0.6 ounces. In the prospecting shaft fair values were obtained at the surface and then barren ground was struck; at 35 feet the shaft again entered ore, and at 37 feet a sample over 24 inches showed 0.35 ounces, while one adjacent to it over the same width gave only 0.5 pennyweights.

Exposures on the main lode that proved to be platiniferous represent a vertical range of 150 feet and there is no reason to believe that the character of the lode is different at considerably greater depths. The same or similar lodes occur in the neighborhood, and platinum has been found in lodes at least ten miles from the main platiniferous lode. Of course the whole region will need and is apt to receive much further investigation before it can be determined whether it will become an important platinum producer. The present conclusion of the authors of the paper is the following: "As to what dimensions production will ultimately attain, it is impossible to make any forecast. The writers do not anticipate a very large output, but, on the other hand, see no reason why, with ordinary good fortune, the company (now working the deposit) should not have a successful career."

JAS. LEWIS HOWE
WASHINGTON AND LEE UNIVERSITY

CORRECTION OF NET ENERGY VALUES

THE direct object of the work of the Pennsylvania Institute of Animal Nutrition has been from its inception and remains the measurement of the net energy values of feeds and the use of these values in the statement of feeding standards for farm animals.

During the life of Dr. H. P. Armsby, the former director of the institute, numerous important contributions were made to the literature of the subject above indicated, and at the time of his lamented death on October 21, 1921, an extensive accumulation of results of experiments remained in an unfinished condition. As a consequence the staff of the institute is now bringing to completion the results of seven years' animal experimentation.

As these materials are assimilated there are coming to light improvements of understanding of the general project such as place us under obligation to recompute and to correct all the net energy values which have been published from the institute. Dr. Armsby himself regarded these results as "tentative" (to use his own word), and therefore subject to revision.

The theoretical basis and the general method of work which has been followed can not be challenged; and the general order of the net energy values remains as previously reported, but the recent progress alluded to has the effect radically to alter certain values which have long been questioned, to improve very greatly the agreement of repeated estimations on the same feed and to place net energy values in general on a new plane of accuracy.

This improved situation is due mainly (1) to an improved understanding of the effects of change of position of the experimental animal on the heat outgo, and a more accurate method of computation of such effects, and (2) to a change in method of computation of net energy values which gives full and proper recognition to the fact that the energy of maintenance is a part of the net energy.

The general recognition of the net energy conception as one which promises great improvement in our understanding of the nutritive requirements of farm animals and the extensive use which is being made of net energy values seem to us to require this notice of a forthcoming revision of the published figures.

E. B. FORBES
THE INSTITUTE OF ANIMAL NUTRITION OF
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PALAEONTOLOGISCHE GESELLSCHAFT

IN an account of recent papers by European workers on the habitat and origin of the Eurypterida (*Amer. Journ. Sci.*, March 1924), Dr. R. Ruedemann says that some of those papers were read at a "meeting of the German Paleontological Society." It should be pointed out that the society to which he refers, though it has a German name, has always been an international society. The president is an Austrian. Holland, Sweden and Great Britain are represented on the committee and the last annual meeting was in Vienna. The society has numbered distinguished American paleontologists among its members (was not Dr. Ruedemann himself one?) and hopes to attract many more. The secretary is Dr.

Fritz Drevermann, Senckenberg Museum, Frankfurt-on-Main, Germany.

F. A. Bather

British Museum of Natural History, London

SCIENTIFIC BOOKS

Statistical Method. By Truman L. Kelley. New York, The Macmillan Company, 1924. xi + 390 pp. + 1 nomogram.

We are living in a period of tremendous increase of interest in statistics—vital, educational, business, economic, and so on. When I was in college, only 25 years ago, it would have been difficult to find a course in statistical theory or even one in which statistical methods were widely used—perhaps least squares as a way of reducing astronomical observations and the kinetic theory of gases as a branch of the theory of heat were the only available courses. To-day an undergraduate might almost obtain a liberal education from statistical courses alone. It is natural that there should be an increasing text-book literature of statistics and of its special fields. Yule's introduction appeared in 1910, is now in its sixth edition, and remains unexcelled in its own way. We have simple books by King and Secrist directed chiefly toward the student of collegiate economics, special works on vital statistics by Whipple and Pearl for the student of public health, and an excellent general text by D. C. Jones. At the moment the latest addition is Kelley's "Statistical Method." Written by a professor of education, it is evidence of the seriousness with which such professors have come to take elaborate statistical investigations.

Kelley's book is not easy; although not primarily a mathematical treatment of its subject, a moderate use of calculus is not made the occasion for apology. The author believes that the elementary statistical needs of biologists, economists, educators and psychologists are about the same and that a book can be written to provide a common foundation for the needs of all. This is good pedagogy. If a mature investigator finds his training in some subject, such as statistics, inadequate for his needs it may be that he can fill the lacuna easiest by a special treatise in which problems in his field (and in no others) are subjected to analysis by that method; if a student of the public health must learn vital statistics it may be that a special treatment such as Whipple's or Pearl's may most easily and rapidly meet his necessities; but if the student is caught young enough he undoubtedly profits most by a general discussion of a subject with illustrations from a variety of its applications and with emphasis on the method rather than on the particular problem used as illustrative material.

The author especially requests critical analysis of his determinations of probable errors and states that he has pursued the policy that as shrewd an estimate as possible of the probable error of a statistical constant is better than no estimate at all. I desire to commend this policy; it is very important for the student of statistics to be mindful of the fact that his is not an exact science and to have constantly before him some estimate of his probable errors. And in this connection, being invited by the author to criticize, I should like to say that I do not approve of carrying numbers out to so many places as he occasionally and others habitually do. These places, when repeatedly used, give a psychological impression of exactness which has an opposing effect to that of the estimate of probable errors; any book which would be sound in practice on probable errors should give considerably more attention than Kelley's does to the matter of significant figures.

A list of titles of the chapters is the quickest way to show the scope of the book: "Tabulation and plotting of (statistical) series," "Graphic methods," "Measurement of central tendencies," "Measures of dispersion," "Normal probability distribution," "Comparable measures," "Fitting of curves to distributions," "Measures of relationship," "Functions involving correlated measures," "Further methods of measuring relationship," "Multiple correlation," "Statistical treatment of sundry special problems," "Index numbers." The method of treatment is essentially Pearsonian, small attention being given to the methods of Edgeworth and the Scandinavian School, but the author does not dismiss in a cavalier fashion the possibility and even probability that such methods may be very useful. On the whole, that shrewdness which he has shown in the estimation of probable errors pervades the whole book in its discussion and critical comment.

At times I have been doubtful about professional pedagogues and about standards of graduate study and of advanced degrees in education; it is a great encouragement to find a professor of education writing a seriously sustained book on statistical method in which the emphasis is not on an arithmetic system but on a mode of thinking.

Edwin B. Wilson

Harvard School of Public Health

SPECIAL ARTICLES

A NEW FORM OF THE EXCLUSION PRINCIPLE IN OPTICAL SPECTRA

The question which, among the numerous quantized energy-states of an atom, will "combine," by means of a transition associated with radiation, is answered by two well-known exclusion principles, according to

which such combinations occur only when the azimuthal quantum number changes by ± 1, and the inner quantum number by 0 or ± 1. In the simple spectra, such as that of sodium, these rules are closely followed, the exceptions being weak lines, produced in the presence of strong electric fields.

In the more complex spectra, the inner quantum rules are still strictly followed, but the azimuth quantum rules suffer changes. In the calcium spectrum, for example, some of the strongest lines arise from combinations between terms, both of which are of type p (Azimuth quantum 2) or of type d (Azimuth quantum 3). Professor Saunders and the writer, in a paper now in press, have advanced evidence, in favor of Bohr's suggestion, that in these "anomalous" states of the atom the two valency electrons are simultaneously shifted to states of higher energy.

A more complicated situation is found in the spectrum of titanium. Investigations of this were begun independently by Dr. and Mrs. Kiess and by the writer. When this fact was realized, it was mutually agreed that those who were first in the field should publish first, and the work of the former authors has just appeared,[1] and will be followed in due time by the writer's. The latter includes the spark spectrum as well as the arc, and brings to light combinational relations of a new type.

The arc spectrum of titanium consists of systems of singlets, triplets and quintets, of which the second is the most extensive. Terms of types s, p, d, f, g, h and i (that is of azimuth quanta 1, 2, 3, 4, 5, 6 and 7) are clearly recognizable. These terms fall sharply into two sets, such that *no two terms in the same set combine with one another,* while any term of one set combines with all terms in the other set for which the azimuth quantum differs by 0 or ± 1. In the spark spectrum, which consists of quartets and pairs, the same division into two sets exists, and, again, terms of the same set do not combine, but a term of one set may combine with any term of the other set for which the azimuth quanta differ by 0, ± 1 or ± 2—thus an f term will combine with p, d, f, g and h terms. The inner quantum rules, and Landé's other rules governing multiplet structure and Zeeman effect are completely observed. The work of Catalan, Meggers and Walters shows that substantially the same set of rules hold in the arc spectra of scandium, vanadium and iron, and the spark spectrum of the first. We have here a quite new form of the first, or "azimuthal" exclusion principle, which appears to hold good in all the more complicated spectra so far analyzed. The relations in the alkaline earths exhibit a transition between the simpler and the more complex rules. Chromium and manganese appear to represent a somewhat later stage in this transition.

It may be remarked also that in the simpler spectra the lowest energy level, or normal state of the atom, is always of small azimuth quantum number (an s term or sometimes a p term), while in the complex spectra so far studied this lowest level is a d or f term of large azimuth quantum.

These relations are likely to have important bearings on the theory of the structure of the outer parts of the atom.

Full details of the writer's work on the titanium spectrum will soon be published in a contribution from this observatory.

HENRY NORRIS RUSSELL

MOUNT WILSON OBSERVATORY,
May 16, 1924

[1] *Journal Optical Society of America, 8,* 607, 1924.

ABSORPTION OF CARBON DIOXIDE THE FIRST STEP IN PHOTOSYNTHESIS

THE classical researches of Brown and Escombe[1] formulated in a clear and concise fashion the laws governing the diffusion of carbon dioxide through the stomata into the leaves during photosynthesis. These investigations demonstrated that the absorption of atmospheric carbon dioxide by an illuminated leaf proceeds at about one half the rate which the same surface of the leaf would possess if it were covered by a constantly renewed film of a solution of caustic alkali. "Or if we assume that the absorption of carbon dioxide in the leaf takes place only through the stomatal openings which occupy at the outside not more than 0.9 per cent. of this leaf area, we arrive at the somewhat remarkable conclusion that during assimilation the absorption per unit area of these openings must be 43 to 64 times as fast as the absorption of a unit area of a freely exposed solution of caustic alkali." Brown and Escombe dealt especially with the purely physical process of the diffusion of carbon dioxide through the stomata. The ascertainment of the agents or leaf constituents which effectuate the absorption constitutes another problem.

While the rate of photosynthesis is governed by the purely physical process of diffusion, the initial stage of the photosynthetic process must depend upon a mechanism which supplies the active centers of photosynthesis with carbon dioxide. Graham stated: "Liquid diffusion of carbonic acid is a slow process compared to its gaseous diffusion, quite as much as days are to minutes." The low partial pressure of CO_2 in the atmosphere and the relatively low solubility of the gas in water have for a long time been recognized as conditions unfavorable for photosynthesis. At 0.03 volume per cent., 1,000 cc of water dissolves at 25° 0.033 cc CO_2. 1,000 grams of *Helianthus* leaves, with an area of 3.3 square meters, contain 850 cc water and would dissolve only 0.027 cc

[1] H. T. Brown and F. Escombe, *Phil. Trans.* Roy. Soc. B. *193,* 223 (1900).

CO_2 under normal conditions. During photosynthesis there is absorbed about 1,500 cc CO_2 by these leaves per hour. For some time it has appeared to us that the first step in photosynthesis is not a simple splitting of carbonic acid under the influence of light, but that the CO_2 undergoes a primary change through absorption by certain constituents of the leaf.

It has been known that vegetable tissue is capable of absorbing CO_2 in quantities considerably above that accounted for by the solubility of the gas in the water of the tissues.[2] Willstaetter and Stoll demonstrated that this phenomenon is shown not only by living leaves but also by the dried leaf material to which water has again been added.

In order to establish more directly the nature of the absorbing substances in the leaves under conditions similar to those employed in our investigations of photosynthesis we have studied the absorptive capacity of dried leaves. For a number of reasons it was desirable to employ concentrations of CO_2 as near to normal as possible. The experimental difficulties are increased by the fact that the post-mortal respiration of the leaf material is relatively high. The absorptive effects are augmented and the accuracy of the determinations increased by using air enriched in CO_2. Accurate results could be obtained only by the complete avoidance of rubber stoppers and connections in the absorptive flasks. The investigations have been unavoidably interrupted, so that a brief report of the findings to date seems desirable.

(1) Dried and ground leaf material to which the same amount of water has been added as originally contained in the leaves, absorbed CO_2 from the air in the dark. In order to increase the accuracy of the analyses the air was enriched to 1.3 per cent. CO_2.

(2) The manner of drying the leaves greatly affects the absorptive capacity; 55–60° in a rapid stream of dry air seems to be best.

(3) Dried and powdered *Helianthus* leaves, to which the same amount of water was added as originally in the leaves and which had been freed of CO_2 by passing a stream of CO_2— free air over them, absorbed at 25° 4.95 mg CO_2 per gram, more than ten times the amount dissolved in the water present.

(4) Leaf material exhibiting high absorptive capacity also had a high rate of post-mortal respiration and *vice versa*. The post-mortal respiration coefficient (CO_2/O_2) averaged about 1.5.

(5) Extraction of the dried leaves with cold water reduced somewhat the absorptive capacity of the leaf material. Extraction with cold absolute alcohol greatly reduced the absorptive capacity. The material extracted by the cold alcohol absorbed only exceedingly small amounts of CO_2. Similarly, heat tends to destroy the absorptive capacity of the leaf material. Extraction with acetone, thus removing most of the pigments, did not affect the absorptive capacity. Extraction with water saturated with ether at 20° (Chibnall-Schryver method for protein extraction) reduced the absorptive capacity 90 per cent. The residue obtained from evaporating the water-ether extract at reduced pressure and 50° absorbed as much CO_2 as the original leaf material.

(6) We are of the opinion that our experiments support the theory that the leaf absorbs CO_2 from the atmosphere by a mechanism similar to that by which the blood of mammals serves in freeing the tissues of this gas. According to our experiments 100 grams of dry leaf material, when moistened, can absorb at 25° and 1.3 per cent. CO_2, 495 mg CO_2 or 272 cc at standard conditions. The dry material constitutes about 15 per cent. of the leaf in its original condition, so that 100 grams of fresh leaf material would on this basis be able to absorb about 41 cc of CO_2. 100 cc of venous blood contains about 50 cc CO_2; of this amount not more than 20 per cent. is dissolved in the water of the blood, the rest being held by the blood plasma and the inorganic constituents.

In the leaf probably the major portion of the CO_2 is absorbed by the proteins on the basis of the carbamino reaction. The effect of this is to increase the concentration of the CO_2 in the cells and to alter the form in which the CO_2 is present. It remains to be determined whether these carbamino compounds can act as photochemical acceptors in the primary photochemical reaction. Our experiments on the action of ultra-violet light on the simpler carbamino acids have, however, led to the same negative results as to the formation of the formaldehyde as those with carbonic acid. The primary union of CO_2 with the proteins of the leaf as the first chemical step in photosynthesis may be of considerable importance in determining the cause for the asymmetric nature of the synthesis of the carbohydrates in the chlorophyllous plant.

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[2] de Saussure, Ostwald's Klassiker, No. 15, p. 43, Boehm, *Ann. Chem.*, *185*, 248 (1876); Willstaetter and Stoll, "Untersuchungen ueber die Assimilation der Kohlensauere," pp. 172–225, Berlin, 1918; Carey, Physiological Researches, *2*, 407 (1923).

THE ILLINOIS STATE ACADEMY OF SCIENCE

THE Illinois State Academy of Science held a very successful meeting in Elgin, on May 1, 2 and 3, with an attendance of nearly 200 members, besides many friends. The convention opened on May 1, with a

general meeting in the evening, at which the retiring President, Dr. W. G. Waterman, of Northwestern University, gave the address. Friday morning and evening were also devoted to general meetings, at which invitation addresses were given. On Friday afternoon the following sections met for the presentation of papers and discussions: Biology and Agriculture; Chemistry and Physics; Geography and Geology; Medicine and Public Health; Psychology and Education; High-school Science, and Mathematics.

There were 73 papers on the program for all the meetings, and most of these will be published in the annual *Transactions*.

On Saturday, May 3, there were three excursions: One to the Elgin Watch Factory and Astronomical Observatory; another, a field trip, to regions of interesting glacial deposits about Elgin. This excursion was led by Dr. M. M. Leighton and Dr. Paul MacClintock. The third excursion was a botanical field trip, and was led by Dr. H. C. Cowles. The White Cedar Swamp, a relic of the glacial age, was studied, and the famous Evergreen Nurseries at Dundee were visited.

At noon on Saturday all three excursion groups met at Trout Park, Elgin, and enjoyed the complimentary luncheon furnished by the Illinois Nature Study Society. Mr. Carl Gronemann, chairman of the local committee of arrangements, ably assisted by many local organizations, did much toward making the convention a pronounced success.

The following officers were elected for 1924–25:

President: W. G. Bain, M.D., Springfield.
Vice-president: C. H. Smith, Chicago.
Secretary: C. Frank Phipps, DeKalb.
Treasurer: W. B. McDougall, Urbana.
Librarian: A. R. Crook, Springfield.

There were 34 candidates elected to membership, making the total membership of the academy about 550.

C. FRANK PHIPPS,
Secretary

THE VIRGINIA ACADEMY OF SCIENCE

THE second annual meeting of the Virginia Academy of Science was held at Washington and Lee University, Lexington, Virginia, on May 2 and 3. The Virginia Section of the American Chemical Society met with the academy.

The presidential address "The church and science" was delivered by the retiring president, Professor Ivey F. Lewis, of the University of Virginia. Dr. C. S. Lind, of the Bureau of Mines, Washington, D. C., gave an address on "Radioactivity."

The following officers were elected for 1924–25:

President: James L. Howe, Washington and Lee University.

Secretary-Treasurer: E. C. L. Miller, Medical College of Virginia.

Member of the Council: Ivey F. Lewis, University of Virginia.

The following scientific program was presented:

A simple and yet fairly accurate method of measuring directly quantities of fluid of the order of one cubic millimeter without resorting to pipettes and dilutions: E. C. L. MILLER.

Corn pith as a substitute for cork in the entomological laboratory: J. B. UNDERHILL.

The effects of various inorganic salts on paramecia: E. V. GRAY.

A comparative study of Bacillus carotovorus Jones and B. aroideae Townsend: A. B. MASSIE.

Plant diseases; their occurrence and importance in Virginia: F. D. FROMME.

Effects of endocrine glands upon frog larvae: C. C. SPEIDEL.

Pollination in Plantago decipiens: LENA B. HENDERSON.

Modern man as related to pre-historic man: R. B. BEAN.

The evolutionary history of the spleen in its relation to blood formation: H. E. JORDAN.

Internal motions in the spiral nebulae and their bearing on cosmogony: H. L. ALDEN.

An unusual migration date for the chimney swallow: I. F. LEWIS.

Digestive enzymes of the coelenterates—Hydra viridis and H. fusca: M. C. YODER.

Ciliogenesis in the oesophagus of the frog tadpole: J. E. KINDRED.

Inheritance of flower color in the garden balsam: D. W. DAVIS and RACHEL TARRAL.

Social and economic status of college students: WM. M. BROWN.

A bacteriological study of the water of Lexington and the swimming pool: W. D. HOYT and D. C. T. TSENG.

Vapor pressure measurements: SIDNEY S. NEGUS.

Perchloric acid as an analytical reagent: JOHN H. YOE.

Examination of a turbine petroleum sludge: ALBERT SALATHE.

A discussion of chemical education was introduced as follows:

The correlation of high-school and college chemistry from the standpoint of the college: GARNETT RYLAND.

The correlation of high-school and college chemistry from the standpoint of the secondary school: LEROY L. SUTHERLAND.

The correlation of college and medical school chemistry: E. C. L. MILLER.

E. C. L. MILLER,
Secretary

THE AMERICAN MATHEMATICAL SOCIETY

THE twenty-first regular western meeting of the American Mathematical Society was held at the Uni-